Middleby Marshall®

technical service manual

This Technical Service Manual includes information for the following oven models:

- **PS200/220/224 Series**
- **PS310/360 Series**
- **PS555/570 Series**

P/N 47829 • Rev. C • V1 • 4/02

CFESA

Commercial Food Equipment Service Association

Middleby is proud to support the
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We recognize and applaud CFESA's ongoing efforts
to improve the quality of technical service in the industry.

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WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.

WARNING

DISCONNECT THE OVEN FROM ITS ELECTRICAL POWER SUPPLY BEFORE SERVICING.

NOTICE

During the warranty period, ALL parts replacement and servicing should be performed by your Middleby Marshall Authorized Service Agent. Service that is performed by parties other than your Middleby Marshall Authorized Service Agent may void your warranty.

NOTICE

Using any parts other than genuine Middleby Marshall factory manufactured parts relieves the manufacturer of all warranty and liability.

NOTICE

Middleby Marshall reserves the right to change specifications at any time.

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SECTION 1
SEQUENCE OF OPERATION

I. GAS OVEN SEQUENCE OF OPERATION

A. Electrical Supply

Gas heated ovens operate on 208/240V, single phase. Standard incoming power configurations are:

1. 4-wire system (PS200 series, PS310/360 series, PS570, PS570S) - 2 single phase 208/240V supply (hot) lines, 1 neutral and 1 ground.
2. 3-wire system (PS360WB70, PS360EWB, PS555, PS570G, PS536) - 2 single phase 208/240V supply (hot) lines and 1 ground.

For all wiring configurations, the voltage when measured from either hot line to neutral should never exceed 130V.

B. Door Switch

Closing the control cabinet door (or machinery compartment door, as appropriate for the oven model) will close the door switch and allow the oven to operate.

Note that the electrical systems will still be "live" if the switch is open, although the oven cannot operate.

The door switch has a bypass position to enable service operation with the door opened. When the door is open, grasp the switch actuator and pull it out as far as possible. This will close the door switch and permit troubleshooting. Closing the control cabinet door will reset the switch.

1. Closing the door switch permits a circuit to go through a fuse (or circuit breaker, as appropriate for the oven model) to one side of the conveyor switch, blower motor switch, cooldown relay and heat switch.
2. Closing the door switch permits a circuit to go through the motor fuse (two 9A or 15A fuses per motor).

C. Conveyor Switch

Closing the conveyor switch permits a circuit to go to the Conveyor Speed Control Module, which:

1. Sends power to the gear motor (conveyor drive motor). The 120VAC signal to the Conveyor Speed Control Module is rectified to a 90VDC signal which is then sent to the gear motor.
2. Allows regulation of conveyor speed. Adjusting the thumbwheel (or digital pushbutton display unit, as appropriate) to the desired conveyor belt speed instructs the Conveyor Speed Control Module to regulate the output to the gear motor. This increases or decreases the conveyor speed as necessary to match the speed setting shown on the thumbwheel or display unit.

D. Blower Switch

Closing the blower switch energizes:

1. The cooling (axial) fan(s).
2. The blower motor contactor (s).

Closing this contactor starts the blower motor(s). When both blower motors are up to speed, centrifugal switches located inside the blower motors (or air switches detecting blower operation, as appropriate for the oven model) will close, setting up the heat circuit.

3. The Temperature Controller.

E. Heat Switch

Closing the heat switch completes a circuit:

1. Through the heat switch.
2. Through the blower motor centrifugal switches (or air switches, as appropriate for the oven model).
3. Through the high limit switch.
4. One circuit then goes to the:
   a. Burner (L1).
   b. Transformer (110V to 24V).
   c. Motor relay coil. On a cold start the heater on this relay takes about 30 seconds to warm up before the relay will energize. This gives an additional prepurge. The relay is not used on ovens with 208/240V burner blower motors.
   d. Burner blower motor. As the motor reaches full operating speed, the centrifugal switch (or air flow switch, as appropriate for the oven model) closes and applies voltage to the burner control. This energizes the ignitor control spark transformer and the pilot valve. The spark then lights the pilot. The flame sensor proves the presence of the pilot flame, and the ignitor control then shuts off the spark. At the same time, the main burner valve is opened. The main burner is then ignited.

      If the pilot does not light within approximately 90 seconds, the oven will shut down.

      The pilot and main gas valve will stay on (open) as long as the heat switch is ON and the flame is proven. If the flame goes out for any reason, the pilot will try to light for 90 seconds, and then go into automatic lockout. To relight the pilot after it has gone into automatic lockout, the burner must be turned OFF for 5 minutes and then turned ON again.

e. For ovens with an On-Off gas regulation system (with solenoid valve): Temperature Controller terminals 4 & 5 (power for the primary relay contacts for the high flame solenoid valve).

For PS360EWB ovens with a modulating gas system and Temperature Controller P/N 32571: Temperature Controller terminals 4 & 5 (input signal to amplifier board).

For all other ovens with a modulating gas system: Temperature Controller terminals 15 & 16 (input signal to amplifier board).

In all ovens, the temperature-sensing thermocouple(s) send a millivolt signal to the temperature controller. As long as the temperature inside the oven is below the set point of the Temperature Controller, the Controller will do the following:

1. For ovens with an On-Off gas regulation system: If the temperature sensed by the thermocouple(s) is below the set point on the Temperature Controller, the Controller energizes the high flame solenoid. When the solenoid is energized, the solenoid valve permits 100% gas flow. Power to the solenoid is cut when the temperature reaches the set point, which closes the valve. This permits on-off gas flow to the burner.

   When power is cut to the high flame solenoid, the burner will remain ON in the low flame mode. When the temperature drops a few degrees, the Temperature Controller will again energize the high flame solenoid, which opens the valve and restores gas flow to 100%.

   An indicator on the Temperature Controller will show whether the high flame solenoid is energized (or whether the burner is activated, which is effectively the same). This indicator varies by Temperature Controller model. Refer to the instructions for the appropriate Temperature Controller for an illustration and description of this indicator.

2. For ovens with a modulating gas system: In response to the signal from the thermocouple(s), the Temperature Controller sends a 4-20mA signal to the amplifier board. The amplifier board converts this to a 0-20VDC signal which is sent to the modulating gas valve. The valve opens or closes in proportion to the signal from the amplifier board, allowing the gas flow to be regulated as required from 0-100%.

   An indicator on the Temperature Controller will show whether the burner is activated. This indicator varies by Temperature Controller model. Refer to the instructions for the appropriate Temperature Controller for an illustration and description of this indicator.

F. High Limit

NOTE: *Most PS200-Series and PS360-series gas ovens use the high limit feature of the Temperature Controller. All other oven models use a separate High Limit Control Module. Refer to the wiring diagram for the appropriate oven model to check whether a separate High Limit Control Module is used.*

The high limit relay will shut the oven burner OFF:

1. If the high limit thermocouple senses an oven temperature above 650°F.
2. If the signal from the high limit thermocouple is lost.

An indicator on the Temperature Controller will show a high limit condition. This indicator varies by Temperature Controller model. Refer to the instructions for the appropriate Temperature Controller for an illustration and description of this indicator.

G. Cooldown

NOTE: *PS200VL-series ovens do not include a cooldown feature.*

When the heat and blower Switches are turned OFF the cooldown relay will allow the blowers to remain ON until the oven temperature falls to 200°F (93°C).

During cooldown, the Temperature Controller will continue to show the oven temperature.

II. ELECTRIC OVEN SEQUENCE OF OPERATION

A. Electrical Supply

Most electrically heated ovens operate on a 208/230/380/440V, 3 phase, 4 wire system. The fourth wire is for a 120 V neutral ground. This 120 V neutral ground eliminates the need for a control transformer. Where a neutral is not available, a 240/110V transformer is supplied.

B. Door Switch

Closing the control cabinet door (or machinery compartment door, as appropriate for the oven model) will close the door switch and allow the oven to operate.

Note that the electrical systems will still be "live" if the switch is open, although the oven cannot operate.

The door switch has a bypass position to enable service operation with the door opened. When the door is open, grasp the switch actuator and pull it out as far as possible. This will close the door switch and permit troubleshooting. Closing the control cabinet door will reset the switch.

Closing the door switch permits a circuit to go through a fuse (or circuit breaker, as appropriate for the oven model) to one side of the conveyor switch, blower motor switch and to the heat switch.

C. Conveyor Switch

Closing the conveyor switch permits a circuit to go to the Conveyor Speed Control Module, which:

1. Sends power to the gear motor (conveyor drive motor). The 120VAC signal to the Conveyor Speed Control Module is rectified to a 90VDC signal which is then sent to the gear motor.
2. Allows regulation of conveyor speed. Adjusting the thumbwheel (or digital pushbutton display unit, as appropriate) to the desired conveyor belt speed instructs the Conveyor Speed Control Module to regulate the output to the gear motor. This increases or decreases the conveyor speed as necessary to match the speed setting shown on the thumbwheel or display unit.

D. Blower Switch

Closing the blower switch energizes:

1. The cooling (axial) fan(s).
2. The blower motor contactor (s).

Closing this contactor starts the blower motor(s). When both blower motors are up to speed, centrifugal switch(es) located inside the rear end of the motor(s) (or air flow switch[es], as appropriate for the oven model) will close, setting up the heat circuit.

3. The Temperature Controller.

E. Heat Switch

Closing the heat switch completes a circuit:

1. Through the heat switch.
2. Through the blower motor centrifugal switch.
3. Through the high limit switch.
4. For ovens with on On-Off heater activation mode: To the primary relay contacts of the Temperature Controller (terminals 4 and 5 for digital controllers, terminals 5 and 6 for analog controllers).

   When the temperature-sensing thermocouple(s) indicate that the oven temperature is below the set point on the Temperature Controller, the Temperature Controller will energize the contactor(s) which in turn energize the heaters.

   When the oven temperature reaches the set point of the Temperature Controller, the Temperature Controller will cut power to the heaters. When the temperature drops a few degrees, the Temperature Controller will again energize the heaters.

   An indicator on the Temperature Controller will show whether the Controller is calling for heat. This indicator varies by Temperature Controller model. Refer to the instructions for the appropriate Temperature Controller for an illustration and description of this indicator.
5. For ovens with a Variable Pulse heater activation system: To terminals 15 and 16 on the temperature controller. In response to the signal from the thermocouple(s), Terminals 15 and 16 send a 4-20mA signal to a controller module that contains an amplifier board and two solid state relays. The relays activate the heating elements at 100% power on a fixed cycle time, for a length of time proportional to the signal from the temperature controller.

   A "HEAT ON" indicator on the Temperature Controller will light to show whether the Controller is calling for heat.

F. High Limit

NOTE: *Electric oven models use a separate High Limit Control Module.*

The High Limit relay will shut the oven burner OFF:

1. If the high limit thermocouple senses an oven temperature above 650°F.
2. If the signal from the high limit thermocouple is lost.

An indicator on the Temperature Controller will show a high limit condition. This indicator varies by Temperature Controller model. Refer to the instructions for the appropriate Temperature Controller for an illustration and description of this indicator.

G. Cooldown

When the heat and blower switches are turned OFF the cooldown relay will allow the blowers to remain ON until the oven temperature falls to 200°F (93°C).

During cooldown, the Temperature Controller will continue to show the oven temperature.

SECTION 2
AIR FLOW AND HEAT TRANSFER

I. TYPES OF HEAT TRANSFER

Heat constantly moves from a warm object to a cold object. Heat moves in three different ways: thorough conduction, through radiation, and through convection. Middleby Marshall conveyor ovens use all three of these paths to cook the product.

- *Conduction* - Heat is transferred through surface contact (such as pizza dough in contact with a pan).
- *Radiation* - Heat is transferred from light-colored objects to dark-colored objects. The darker the color of an object, the greater the amount of heat that it absorbs. The lighter the color of an object, the greater the amount of heat that it reflects. Middleby ovens use light-colored interiors (aluminized or stainless steel, depending on the oven model) to reflect as much heat as possible to the product.
- *Convection* - Heated air will transfer heat to objects with which it comes into contact. Unless the air flow is controlled, hot air will rise and be replaced by cooler air. Middleby Marshall ovens use blowers (one or two large fans, depending on the oven model) to force air through adjustable air fingers onto the product.

The intensity of the heat at the point at which it is sensed is called temperature. The difference in temperature between the food product and the heat source - that is, the pan, oven interior, or heated air, as described above - determines the speed at which the heat flows. The greater the difference in temperature, the faster the heat flows to the product.

In Middleby Marshall conveyor ovens, the heat transfer from conduction is greatly dependent on the customer's product and cooking surface (pans, etc.). Likewise, the heat transfer from radiation is effectively constant, because the color of the oven interior cannot be changed. For these reasons, the best way to optimize heat transfer is by regulating the convection air. This can be done in two ways:

- Adjusting the blowers and blower speed to change the quantity and velocity of air delivered onto the product.
- Adjusting the air finger configuration to change the pattern in which the vertical columns of air are delivered to the product.

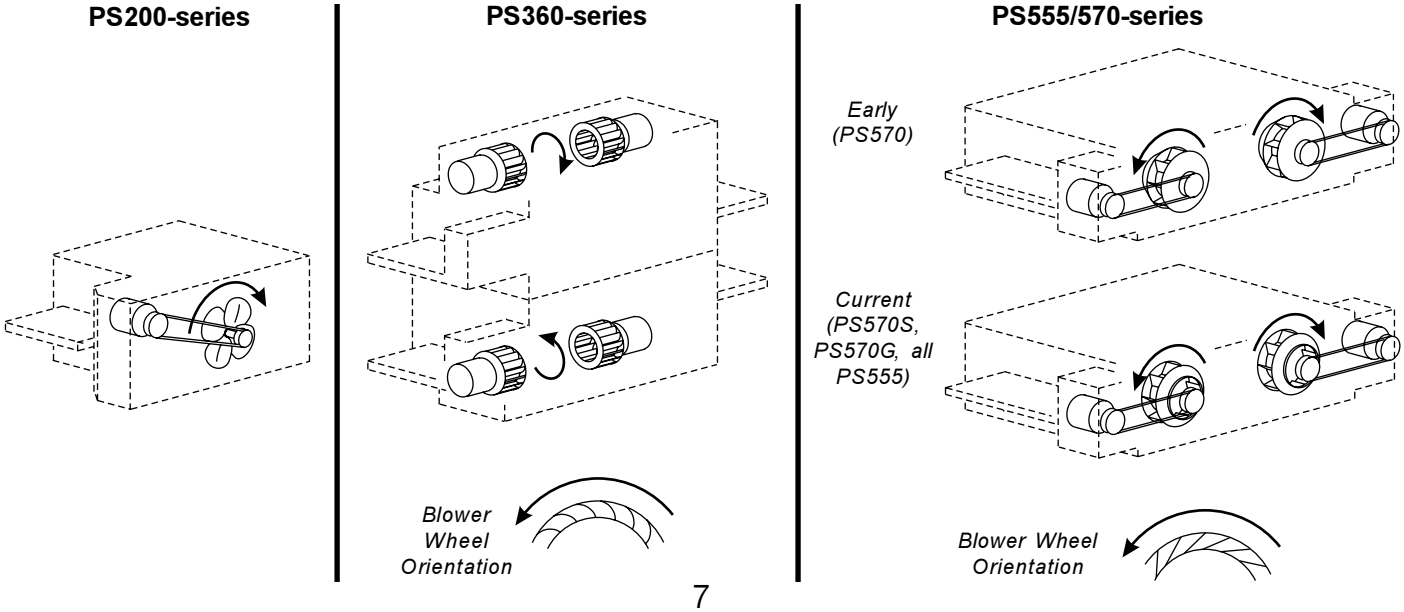
II. BLOWERS AND BLOWER SPEED

A. *PS200-series ovens*

PS200-series ovens have a single blower motor mounted inside the machinery compartment, with a pulley on the end of the motor shaft. A belt connects this pulley to another on the shaft of the blower fan. The air velocity can be changed by using a larger or smaller pulley on the motor shaft, and changing the length of the belt to match the new pulley. See Figure 1.

However, note that there are only two approved belt/pulley combinations for PS200-series ovens; one for 60Hz ovens, and one for 50Hz ovens. Field modifications to these approved combinations are not permitted unless under the specific directions of the Middleby Technical Service Department. Any changes to convection air delivery MUST be made using the air fingers.

Figure 1
Blowers, belts and pulleys



B. *PS360-series ovens*

PS360-series ovens feature two blower motors. A blower wheel is fastened onto the end of the motor shaft. In order to adjust the amount and speed of heated air that is directed by the blower wheels, it is necessary to change the size of the wheels and/or change the speed of the motor. See Figure 1.

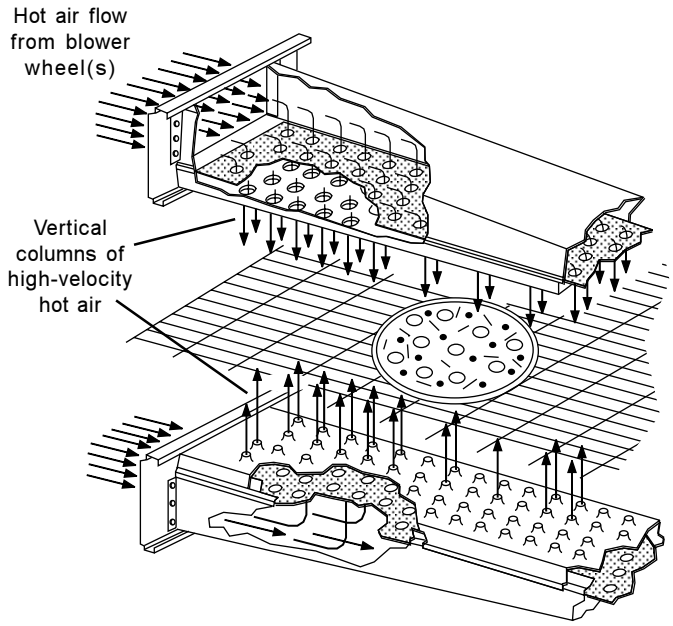
Each PS360-series oven model has a specific combination of blower motor and blower wheel. Field modifications to these approved combinations are not permitted unless under the specific directions of the Middleby Technical Service Department. Any changes to convection air delivery MUST be made using the air fingers.

C. *PS555/570-series ovens*

PS555/570-series ovens have one blower motor mounted inside each of the end compartments of the oven, with a pulley on the end of the motor shaft. The oven has two blower wheels; a belt connects each motor pulley to a pulley on the end of one of the blower wheel shafts. The air velocity can be changed by using a larger or smaller pulley on the motor shaft, and changing the length of the belt to match the new pulley. See Figure 1.

Some customers have a specific belt/pulley combination approved by Middleby Marshall, while others use a "standard" configuration. Field modifications to these approved combinations are not permitted unless under the specific directions of the Middleby Technical Service Department.

Figure 2
Air finger operation



III. AIR FINGERS

A. Description and Function

Air fingers direct the heated air from the blowers into vertical jets that are directed at the top and bottom of the conveyor belt. Each air finger configuration has been tested to optimally cook a specific customer's product. As a rule, air finger configurations should NOT be changed from customer specifications without direct instructions from the Middleby Technical Services Department.

Middleby uses two main types of air fingers:

- PS300/350 and early PS310/360 ovens used a shutter-type air finger assembly. The finger is assembled from a manifold, inner plate and outer plate. The inner plate is assembled from two separate plates, each with a series of holes, that are riveted together. The plates can be repositioned relative to each other to restrict the air flow through the holes as necessary. These fingers are no longer in general use, but may still be found in older ovens in the field. See Figure 3.
- All current ovens use an air finger which is composed of a manifold, inner plate, and outer plate. No adjustments are necessary or possible to these fingers, but a wide variety of styles is available to meet different customers' baking needs. See Figure 4.

Figure 3
PS300/350 air finger with shutter plate

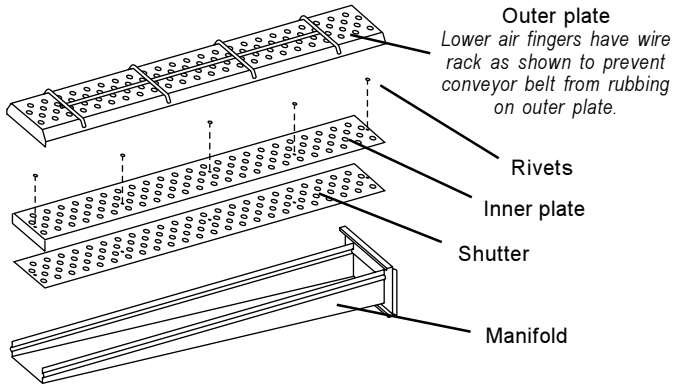
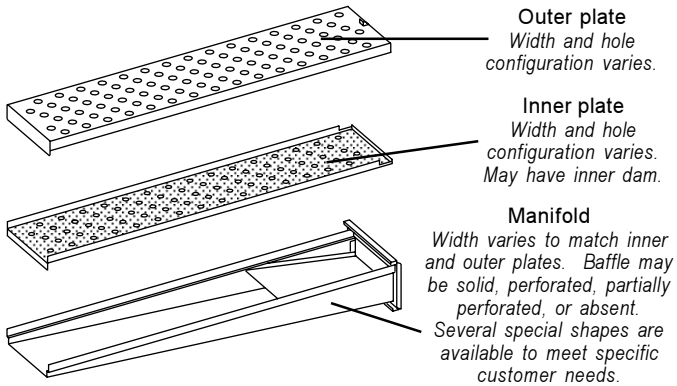

Outer plate
Lower air fingers have wire rack as shown to prevent conveyor belt from rubbing on outer plate.
Rivets
Inner plate
Shutter
Manifold

Figure 4
Current standard air finger (all oven models)


Outer plate
Width and hole configuration varies.
Inner plate
Width and hole configuration varies. May have inner dam.
Manifold
Width varies to match inner and outer plates. Baffle may be solid, perforated, partially perforated, or absent. Several special shapes are available to meet specific customer needs.

IV. OVEN CAPACITY

Oven capacity is generally not a service issue. However, when reporting a service problem, customers may use terms relating to capacity, such as bake time, belt time, time of delivery, etc. This information is provided as a reference for understanding these terms.

A. Conveyor Speed and Bake Time

Middleby Marshall conveyor ovens display the Conveyor Speed on the Thumbwheel (or on the display of the Digital Speed Controller, as appropriate for the oven model). Conveyor Speed is also called Bake Time.

Conveyor Speed (Bake Time) is a *leading edge to leading edge* measurement. That is, it is the elapsed time from the leading edge of the product entering the bake chamber to the leading edge of the product leaving the bake chamber. See Figure 9.

B. Belt Time

Belt Time is a measurement used by several customers. It is a *trailing edge to trailing edge* measurement. That is, it is the elapsed time from the trailing edge of the product entering the bake chamber to the trailing edge of the product leaving the bake chamber. See Figure 10.

Note that belt time is equal in length to conveyor speed (bake time), although the time is measured during a different period of the baking process.

C. Time of Delivery (TOD)

Time of delivery (TOD) is a *leading edge to trailing edge* measurement. That is, it is the elapsed time from when the leading edge of the product enters the bake chamber to when the trailing edge of the product leaves the bake chamber. See Figure 11.

Figure 9 - Conveyor Speed (Bake Time)

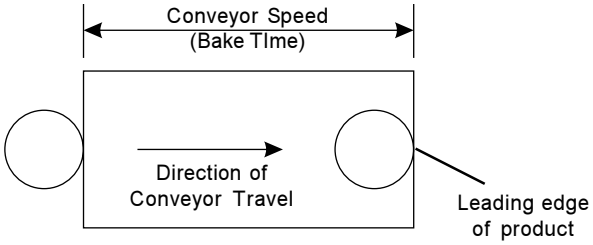


Figure 10 - Belt Time

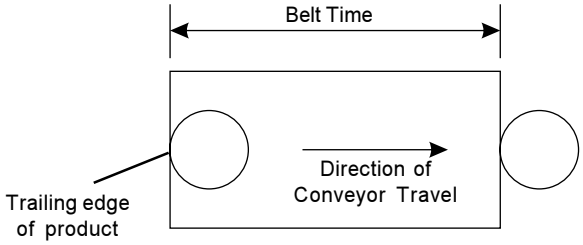
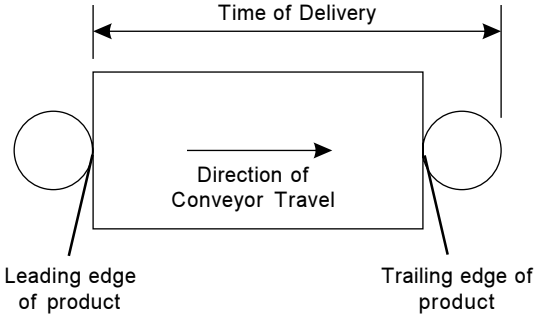


Figure 11 - Time of Delivery



D. Formulas for Determining Time of Delivery (TOD) and Oven Capacity per Hour

1. *Time of Delivery (TOD)*

$$\text{Time of Delivery (TOD)} = \frac{\text{Conveyor Speed}}{\text{Bake Chamber Length}} \times (\text{Bake Chamber Length} + \text{Product Diameter})$$

Example: PS570S Oven, 7:00 Bake Time, 16” Product Diameter = $\frac{7 \text{ mins.}}{70”} \times (70” + 16”)$ = **8.6 mins. (8:36)**

2. *Oven Capacity/Hour*

$$\text{Oven Capacity/Hour} = \frac{(\text{Bake Chamber Length} + \text{Product Diameter}) \times \text{Bake Chamber Depth}}{\text{Product Diameter}^2} \times \frac{60 \text{ min./hr.}}{\text{TOD}}$$

Example: PS570S Oven, 7:00 Bake Time, 16” Product Diameter = $\frac{(70” + 16”) \times 32”}{256 \text{ in.}^2} \times 6.98$ = **75 pizzas/hr.**

Figure 16
Current pickup assembly - side view

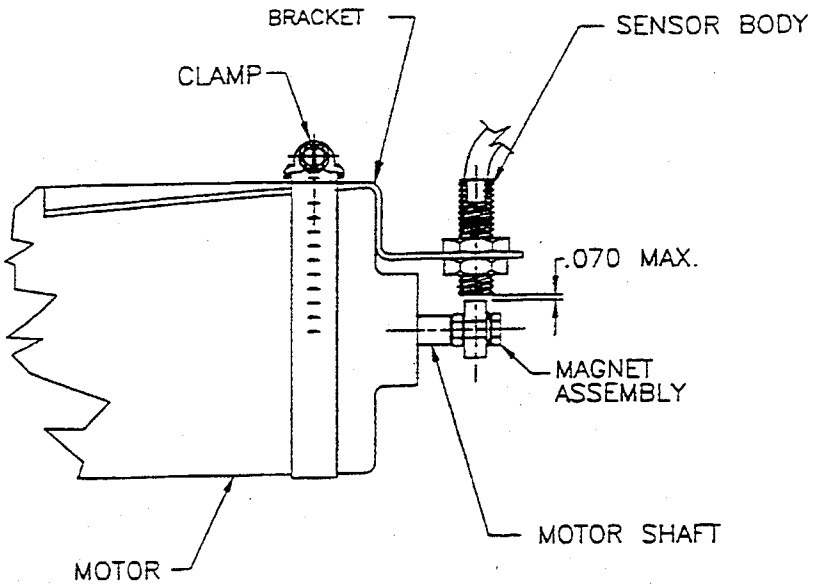
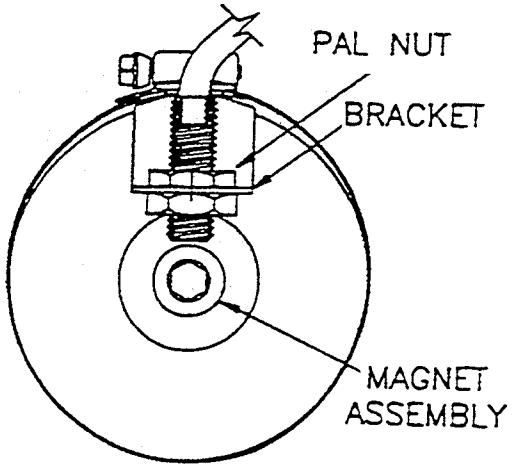


Figure 17
Current pickup assembly - end view



D. Controller/Motor Failure

When the conveyor speed controller fails, it is very possible that a shorted conveyor motor caused the problem. Unless the motor is changed, the installation of another conveyor speed controller will simply burn up the new controller.

You are STRONGLY ADVISED to bypass the speed controller and install the tester unit shown in Figure 18 before replacing any speed controller that has burned out. This will identify the source of the problem - the speed controller or the motor. It is much less expensive to burn out the tester than another speed controller.

The components for this tester can be purchased at any electrical supply store. The tester is not as accurate or sensitive as the speed controller, and so should NOT be left in place on the oven after servicing!

Components needed for the field tester:

- Full-wave AC-DC bridge, 400V, 4A
- Light dimmer switch, 5A
- In-line 5A AC fuse enclosed in plastic case
- 2 alligator clips

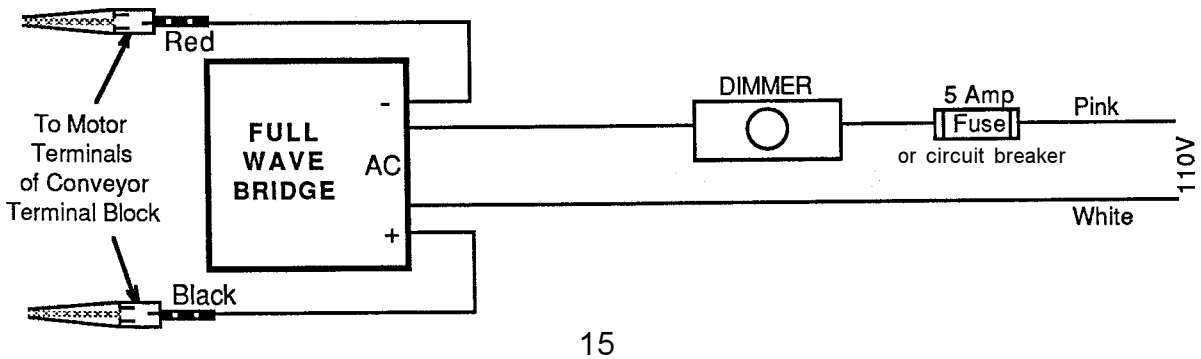
***CAUTION:* DO NOT turn the conveyor switch ON while the field tester is connected!**

1. Disconnect the motor lead wires and attach to the field tester as shown in Figure 18. Depending on the oven model, you can simply use the black and red gear motor leads, or the remote leads at the terminal block connection.

   To reverse the conveyor motor direction, simply interchange the black and red leads.

2. To start the test, the dimmer switch should be turned until the motor begins to operate. The switch can then be turned down to the desired motor speed.

Figure 18
Field Tester for Conveyor Drive Motor



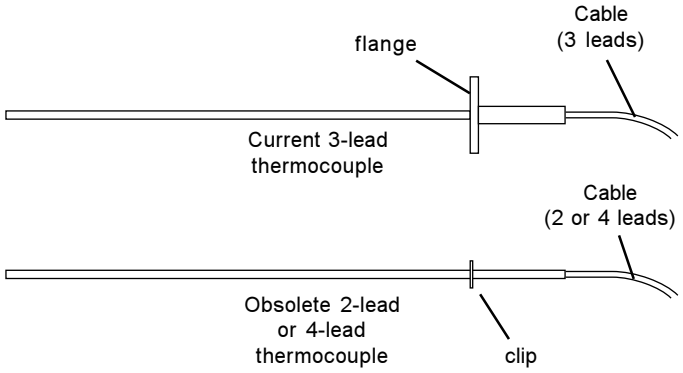
IV. THERMOCOUPLES

All temperature controller and high limit functions are based on input from thermocouples. When two wires composed of dissimilar metals are joined together and one of the ends is heated, a continuous current flow is generated. Middleby ovens use a Type J (iron constant) thermocouple. The iron wire increases the number of dissimilar metal junctions in the circuit.

Middleby has used several types of thermocouples. All can be replaced with the current version. Refer to Figure 24 for illustrations.

- A two-lead thermocouple with a small retaining clip. Used for EITHER temperature-sensing OR high-limit functions. This type is no longer available.
- A four-lead thermocouple with a small retaining clip. This is a dual-function unit that sends its signal to the temperature controller and to a separate high limit control module. This type is no longer available.
- A three-lead thermocouple with a separate ground lead, a shielded cable and a large mounting flange. This is the only type of thermocouple available from Middleby at this time. If it is used to replace a four-lead dual-function thermocouple, two complete and separate thermocouples will have to be installed.

Figure 24 - Thermocouples



A. Part Number Reference - Thermocouples

Part numbers are provided ONLY for the current, 3-lead thermocouple kits. These thermocouples include instructions for replacing all previous thermocouple designs, in all oven models.

P/N	*Description*
33984	Kit, thermocouple, PS360-series or PS555/570 series
33985	Kit, thermocouple, PS200-series or PS536

B. Thermocouple Functions

1. Temperature-sensing thermocouple(s)

   All thermocouples monitor oven temperature. However, Middleby uses the term “temperature-sensing thermocouple” in reference to thermocouples that send their signal to the temperature controller instead of to a separate high limit control module.

   On ovens that do NOT include a separate high-limit control module (this includes most PS200-series and PS360-series gas ovens), this thermocouple signal is used to monitor the oven temperature for regulating the gas flow/heater activation, AND to activate the high limit warning in case of an overtemp condition.

   Middleby ovens use from one to three temperature-sensing thermocouples, depending on the oven model.

   Temperature-sensing thermocouples are used on all oven models and are connected to Terminals 7 and 8 on the temperature controller. Based on the signal from this thermocouple, the temperature controller:

   - Calls for heat from the burner/heating elements to maintain the set point (output from Terminals 4 & 5 for on-off electric and gas ovens; output from Terminals 15 & 16 for variable pulse electric and modulating gas ovens).
   - Controls the cooldown feature if the HEAT switch is turned off while the oven is above the cooldown temperature (output from Terminals 9 & 10).
   - On ovens without a separate high limit control module (most PS200-series and PS360-series gas and electric ovens), the oven temperature sensed by this thermocouple is also used to activate the high limit warning (output from Terminals 11 & 12).

2. High limit thermocouple

   Middleby uses the term “high limit thermocouple” in reference to the thermocouple that sends its signal solely to the separate high limit control module.

   If the oven does not have a separate high limit control module, there is no high limit thermocouple. On these ovens, the temperature-sensing thermocouple(s) control high limit activation.

C. Troubleshooting

1. Open thermocouple

   An open in a thermocouple will cause the temperature controller to read the maximum temperature (usually 909°F/487°C). This causes the following:

   - On ovens without a separate high limit control module, an open thermocouple triggers the high limit alarm. This shuts down the burner. After the open has been corrected, the high limit will need to be reset to allow the oven to resume operation.
   - On ovens with a separate high limit control module, an open temperature-sensing thermocouple causes the temperature controller to stop calling for heat. This shuts down the burner.
   - On ovens with a separate high limit control module, an open high limit thermocouple will trigger the high limit control module to shut down the burner. Note that the high limit control will need to be reset after the open is corrected before the oven can return to operation.

2. Checking the thermocouple with a DC millivolt meter

   It is possible to check that a thermocouple is reading accurately by using a multimeter set to read DC millivolts. At 32°F/0°C the thermocouple should read 0 mVDC. This can be checked by inserting the thermocouple into an ice bath for several minutes. At 72°F/22°C the reading should be 1.134mVDC.

   You can use the chart below by checking the temperature at the thermocouple's junction terminals. This is called the *Junction Temperature*.

Figure 24 - Thermocouple millivolt readings at various operating and junction temperatures

		OVEN TEMPERATURE										
		200°F 93°C	250°F 121°C	300°F 149°C	325°F 163°C	350°F 177°C	400°F 204°C	425°F 218°C	450°F 232°C	500°F 260°C	550°F 288°C	600°F 315°C
JUNCTION TEMPERATURE	90°F(32°C)	3.26	4.77	6.30	7.06	7.83	9.37	10.14	10.91	12.46	14.00	15.53
	88°F(31°C)	3.32	4.83	6.36	7.12	7.89	9.43	10.20	10.97	12.51	14.05	15.59
	86°F(25°C)	3.37	4.88	6.41	7.17	7.94	9.49	10.26	11.03	12.57	14.11	15.65
	84°F(29°C)	3.43	4.94	6.47	7.23	8.00	9.54	10.31	11.09	12.63	14.19	15.71
	82°F(28°C)	3.49	5.00	6.53	7.29	8.06	9.60	10.37	11.14	12.69	14.23	15.76
	80°F(27°C)	3.55	5.06	6.59	7.35	8.12	9.66	10.43	11.20	12.74	14.28	15.82
	78°F(26°C)	3.60	5.11	6.64	7.40	8.17	9.72	10.49	11.26	12.80	14.34	15.88
	76°F(24°C)	3.66	5.17	6.70	7.46	8.23	9.77	10.55	11.32	12.86	14.40	15.94
	75°F(24°C)	3.69	5.20	6.73	7.49	8.26	9.80	10.57	11.35	12.89	14.43	15.97
	74°F(23°C)	3.72	5.23	6.76	7.52	8.29	9.83	10.60	11.37	12.92	14.46	15.99
	72°F(22°C)	3.78	5.29	6.82	7.58	8.35	9.89	10.66	11.43	12.97	14.51	16.05
	70°F(21°C)	3.83	5.34	6.87	7.63	8.40	9.95	10.72	11.49	13.03	14.57	16.11
	68°F(20°C)	3.89	5.40	6.93	7.69	8.46	10.00	10.78	11.55	13.09	14.63	16.17
	66°F(19°C)	3.95	5.46	6.99	7.75	8.52	10.06	10.83	11.61	13.15	14.69	16.23
	64°F(18°C)	4.01	5.52	7.05	7.81	8.58	10.12	10.89	11.66	13.20	14.74	16.28
	62°F(17°C)	4.06	5.57	7.10	7.86	8.63	10.18	10.95	11.72	13.26	14.80	16.34
	60°F(16°C)	4.12	5.63	7.16	7.92	8.69	10.24	11.01	11.78	13.32	14.86	16.40

D. Pilot/Ignitor Assembly

The pilot assembly is attached to the end of the pilot line. It consists of an ignitor electrode/flame sensor, a pilot shield and the pilot burner. See Figure 63.

The pilot assembly includes a safety circuit. An electrical current is sent to the flame sensor probe to prove the presence of the pilot flame. When the spark ignites the pilot, a circuit is completed THROUGH THE FLAME from the flame sensor probe to the pilot burner, which is grounded. This safety circuit must be completed before the pilot will light.

1. Pilot Shield

   The pilot shield is a plate located on the bottom of the pilot. It prevents drafts, etc. from blowing the pilot flame away from the sensing probe. See Figure 64.

2. Flame target

   The flame target aids in distributing the flame from the end of the venturi. See Figure 65.

   - PS310/360-series ovens built prior to 6/87 are not equipped with a flame target. The burner on these ovens resembles the one shownin Figure 64.
   - The angled flame target is used on:
     - PS200-series ovens built through 3/02.
     - PS310, PS314, PS360 and PS360WB ovens built 6/87 or later.
     - PS570S ovens.

     All of these ovens use a 120V burner blower motor. Most units equipped with the 120V burner blower motor also use the angled flame target.
   - The round flame target is used on:
     - PS200-series ovens built 4/02 or later.
     - PS360EWB and PS360WB70 ovens equipped with the Wayne burner system.
     - PS555 and PS570G ovens.

     All of these ovens use a 208/240V burner blower motor. All ovens equipped with the line voltage burner blower motor use the round flame target.

Figure 63 - Pilot/ignitor assembly

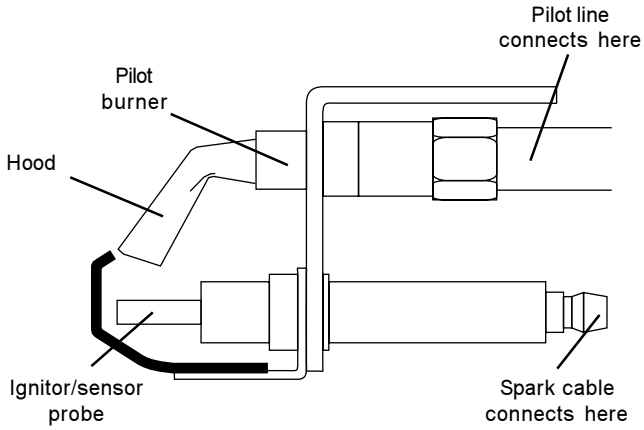


Figure 64
End of burner without flame target showing pilot shield

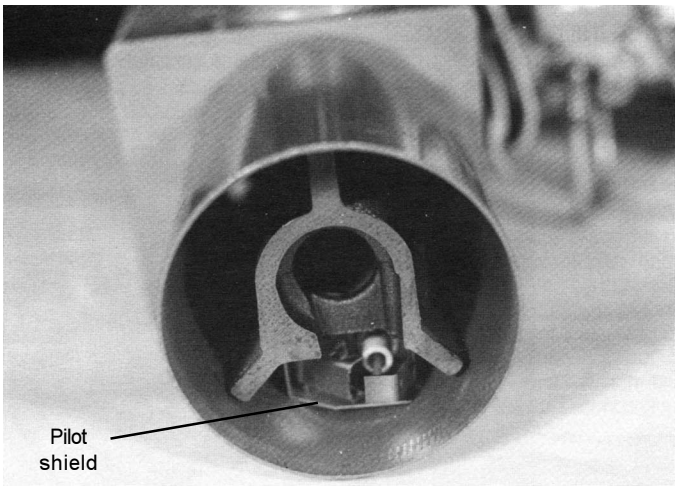
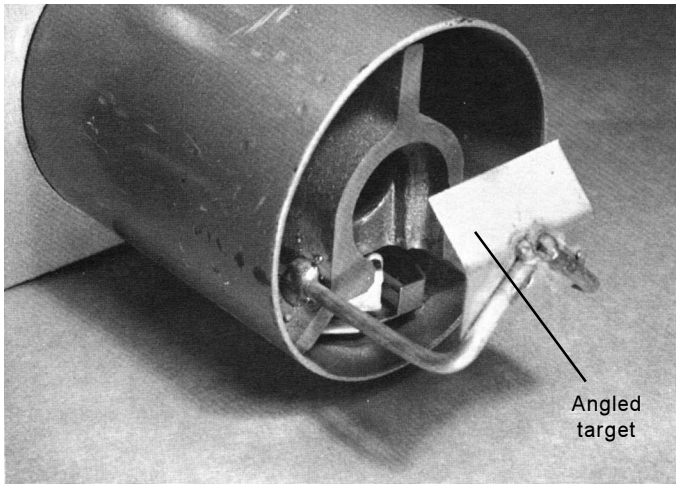
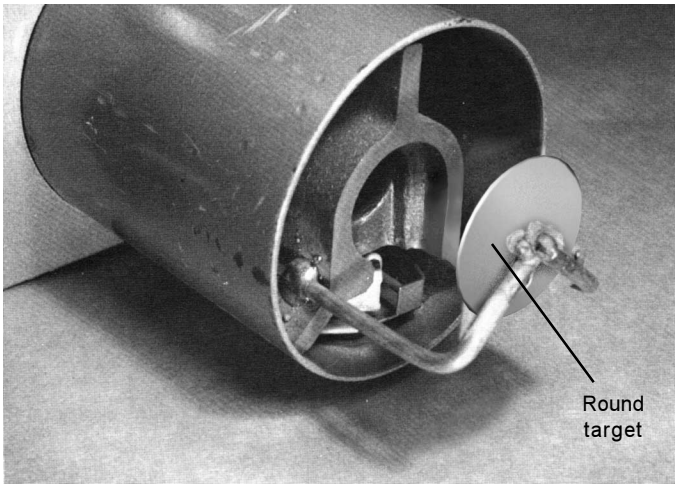


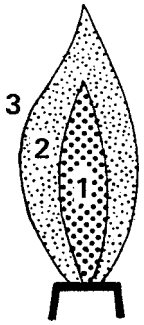
Figure 65
Flame targets





3. Pilot and Proof of Pilot Flame Rectification

Figure 66
Flame structure



With standing pilots, heat is a necessary ingredient for proper thermocouple operation. But this is not the case with IIDS (Intermittent Ignition Device Systems) when flame conduction or rectification is used. To better understand the principles of flame conduction and rectification, we must first understand the structure of a gas flame. See Figure 66.

With the proper air-gas ratio to give a blue pilot flame, three zones exist.

Zone 1: An inner, fuel-rich cone that will not burn because excess fuel is present.

Zone 2: Around the inner, fuel-rich cone is a blue envelope. In this area is a mixture of vapor from the fuel-rich inner cone and the secondary, or surrounding, air. This is where combustion occurs.

Zone 3: Outside the blue envelope is a third zone that contains an excessive quantity of air and will not burn.

Of concern is the second, or combustion area. This is where the burning occurs and is the area that is of prime importance for good flame sensor location.

Flame Rectification

With flame rectification, two probes with different surface areas are exposed to a flame - in this case, the pilot flame. The probe with the larger surface area attracts more free electrons and, as a result, becomes the negative probe. Therefore, current is conducted through the flame from the positive probe to the negative probe. See Figure 67.

Note also that the AC voltage sine wave has not changed, but the negative portion of the current sine wave has been chopped off. This positive portion now represents a DC current. This is the phenomenon of flame rectification.

To apply this principle to an IID (Intermittent Ignition Device - in this case, the pilot/ignitor assembly), a pilot and flame sensor have been substituted for the two probes (See Figure 68). After the pilot is ignited, a DC current flow of 2.0μA (microamps) or more is conducted through the flame, from the flame sensor (the positive probe) to the pilot tip (the negative probe). The pilot tip, acting as the negative probe, completes the circuit to ground. The IID sensing circuit uses this DC current flow to energize a relay and open the main burner gas valve.

Figure 67 - Flame rectification

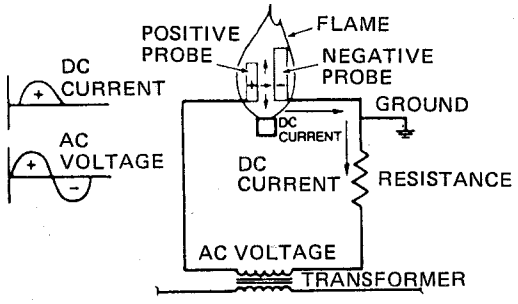
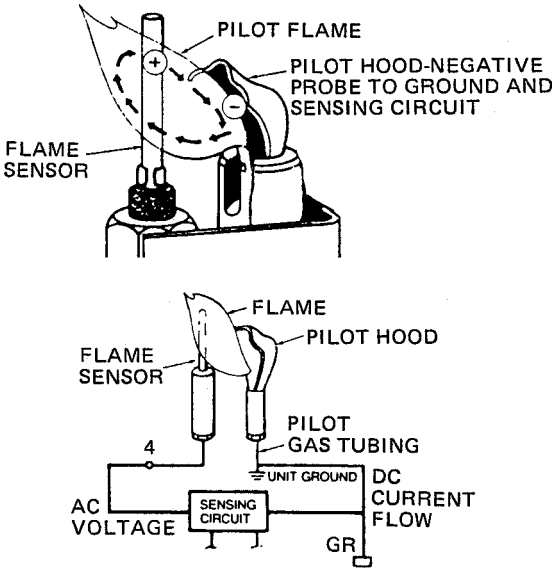


Figure 68 - Pilot and probe



THE FOLLOWING CONDITIONS WILL HAVE A DIRECT BEARING ON EVERY IID APPLICATION:

Voltage

The supply voltage to the ignition controls should be within the following ranges:

- 120VAC controls – 102 to 132VAC
- 24VAC controls – 21 to 26.5VAC

24VAC systems should use transformers that will provide adequate power under maximum load conditions.

Gas Pressure

Inlet gas pressures

- Natural gas, Wayne burner - 6-12" W.C. (14.9-29.9 mbar)
- Propane, Wayne burner - 11½-12" W.C. (28.7-29.9 mbar)
- Midco burner (all gases) - 6-14" W.C. (14.9-34.9 mbar)

Regulated gas pressures

- Natural gas, Wayne burner - 3.5" W.C. (8.7 mbar)
- Propane, Wayne burner - 10" W.C. (24.9 mbar)
- Midco burner (all gases) - 3-5" W.C. (7.5-12.5 mbar)

Pilot gas pressures

- Natural gas, Wayne burner - 3½-4" W.C. (8.71-9.95 mbar)
- Propane, Wayne burner - 8-10" W.C. (19.9-24.9 mbar)
- Midco burner (all gases) - 5-6" W.C. (12.5-14.9 mbar)

Temperature

Ignition controls should not be exposed to temperatures exceeding 140°F (60°C) or less than -40°F (-40°C).

Pilot Application

The pilot and flame sensor application is the most critical aspect of the IID application.

The pilot flame must make contact with the pilot tip and surround the flame sensor probe. A multimeter or ampmeter set to read microamps (mA) is necessary to verify that the proper amount of current is being maintained through the pilot flame. **The minimum value required is 2.0 mA.** Rectification-based ignition systems respond in less than 0.8 of a second to a loss of flame. If the minimum signal is not being maintained at all times, OR if the pilot flame is briefly directed away from the flame sensor or pilot tip, the main gas valve may cycle rapidly ("chattering") or the burner may be prevented from activating.

Other conditions that can cause the failure of the main burner to activate, OR chattering of the burner, are:

1. Pilot flame is too small.
2. Gas pressure is too low for proper pilot flame impingement on the flame sensor.

In these cases, the pilot may ignite, but the main burner gas valve will not be energized. It is also possible for drafts or unusual air currents to deflect the pilot flame away from the flame sensor. Deflection of the pilot flame may also be caused by main burner ignition concussion or roll-out of the main burner flame.

An additional point to be considered is the condition of the pilot flame. If the pilot flame is hard and blowing, the grounding area of the pilot is reduced to a point where the necessary current is not being maintained, and a shutdown of the system will result.

The positioning of the flame sensor is also critical in the pilot application. Positioning of the flame sensor should be such that it will be in contact with the second, or combustion area of the pilot flame. Passing the flame sensor through the inner cone of the pilot flame is not a recommended procedure. For this reason, a short flame sensor may provide a superior signal over a longer one. The final determination of the sensor location (length) is best determined by the use of a multimeter set to read microamps (μA).

E. Burner Blower Motor

The burner blower motor is located on the side or top of the burner housing. Some blowers use a flexible tube to connect the blower to the burner, depending on the available space inside the machinery compartment. The burner blower motor drives a blower wheel located in a housing attached to the end of the motor that is the primary air supply for combustion. The motor requires no lubrication.

Depending on the oven model, the burner motor operates on either 120V or 208/240V (line voltage). 120V motors have an internal centrifugal switch that controls the 24V power supply to the gas valve (see *Burner Blower Motor Centrifugal Safety Switch* on Page 80). 208/240V motors use a separate air pressure safety switch to sense blower operation (see *Air Pressure Safety Switch* on Page 81). This safety feature prevents burner operation in case of motor failure.

F. Air Shutter

The air shutter is a round metal plate located on the open end of the burner blower wheel. Adjusting the position of the shutter will increase or decrease the amount of air that is permitted into the plenum for combustion. Rotate the plate in a counterclockwise direction to increase the air supply, or in a clockwise direction to reduce the air supply.

You can insert a drill bit into the shutter gap to check the size of the opening. Refer to Figure 69 for the recommended opening sizes.

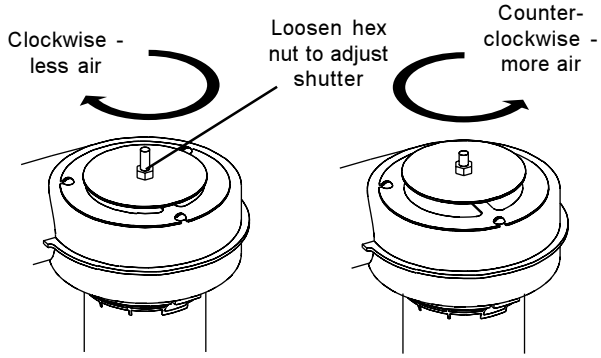
Early Midco burners use an adjustment screw on the front wall of the plenum to adjust the airflow. If it is not possible to adjust the air supply properly using the screw, a retrofit kit is available (P/N 36829) to install the external air shutter shown in Figure 69.

Figure 69
Air shutter adjustment

Wayne burner

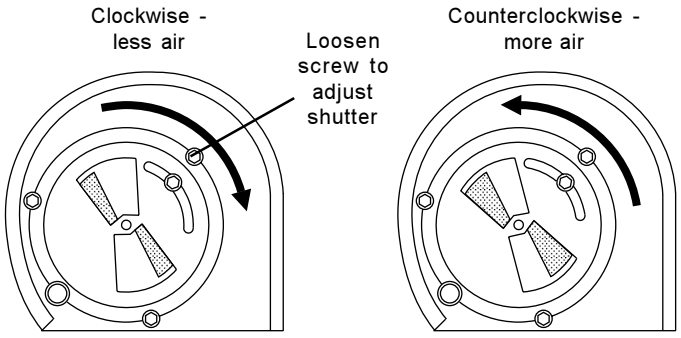
Standard openings:

- 1/4"/6.4mm for natural gas ovens
- 3/8"/9.5mm for propane ovens



Midco burner

Standard opening 5/16"/7.9mm (all gases)



K. Modulating Gas Valve (if so equipped)

Ovens that use a PID (modulated) gas regulation system are equipped with a modulating gas valve instead of a solenoid valve. The valve is located between the combination gas control valve and the burner.

In response to the millivolt signal from the thermocouple, the Digital Temperature Controller sends a 4-20mA signal to an amplifer board. The board, in turn, passes on a 0-20VDC signal to the modulating valve itself. The valve opens or closes proportionally to the signal from the amplifier board, allowing any setting from 0-100% gas flow.

When the oven is switched on, gas demand is at its peak and the valve is fully open, permitting 100% gas flow. As the oven's temperature approaches the set point, the valve slowly begins to close, restricting gas flow to the 35-60% range. After the oven is fully preheated, the gas flow usually stabilizes at about 30%. The actual oven temperature can remain constant, with NO temperature swing, because the valve is adjusted constantly according to the demand.

Modulating valves are used on all PS360EWB, PS555, and PS570G gas ovens. They are also used on PS200 ovens produced 4/02 or later and PS570S ovens produced 9/00 or later.

The Model PS360EWB oven uses a Maxitrol M520 modulating valve with a 3/4" gas line, P/N 32570. All other Middleby oven models equipped with a modulating valve use the Maxitrol M420 valve with a 1/2" gas line, P/N 41647.

The modulating valve features a bypass adjustment screw, shown in Figure 71. For all ovens except the PS536, the screw should ALWAYS remain fully closed; no adjustment is necessary. The screw is pre-set to the fully-closed position from the factory. If the screw is adjusted to any setting other than fully-closed, the oven may not be able to maintain the set point temperature.

IMPORTANT: **For proper functioning of the modulating valve, the temperature controller *MUST* be set to the PID operating mode. Refer to *Temperature Controller* on Page 31.**

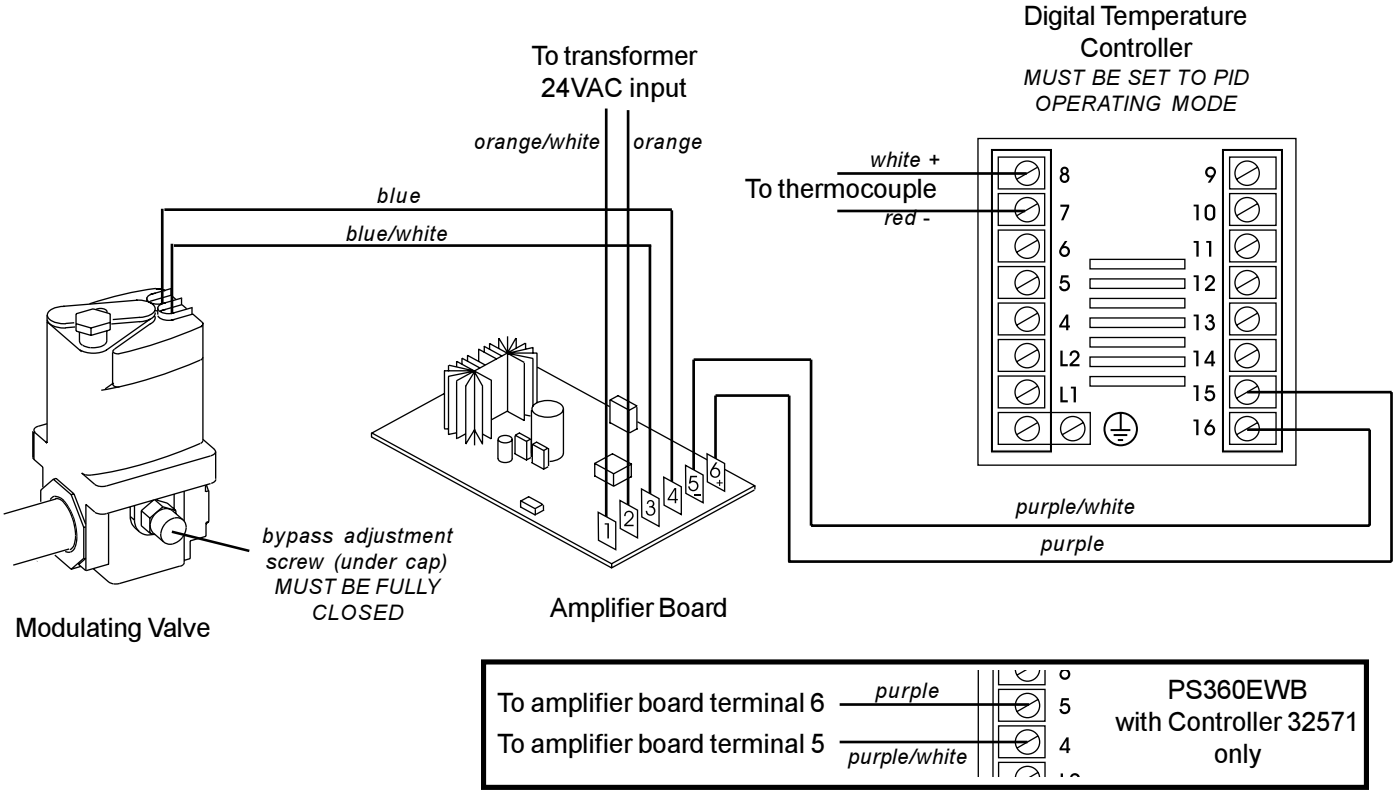
L. Amplifier Board (ovens with a modulating gas valve only)

Ovens equipped with a modulating gas valve have an amplifier board mounted inside the machinery compartment.

In response to the millivolt signal from the thermocouple, the Digital Temperature Controller sends a 4-20mA signal to the amplifer board. The board, in turn, passes on a 0-20VDC signal to the modulating valve. The valve opens or closes proportionally to the signal from the amplifier board, allowing any setting from 0-100% gas flow.

All Middleby oven models equipped with a modulating valve use amplifier board P/N 31651.

Figure 71 - Modulating Gas System



M. Combination Gas Control Valve

1. Part Number Reference - Combination Gas Valve

- PS360WB70 and PS360EWB ovens are equipped with a 3/4" (19.05mm) gas line. This requires the use of Combination Gas Valve P/N 32569. The valve has a tan plastic cover with a blue On/Off knob.
- All other oven models are equipped with a 1/2" (12.7mm) gas line.
  - Through 10/01 - these ovens used Valve P/N 28092-0017. The valve operated on a 60 Hz supply, had a tan plastic cover and a blue On/Off knob.
  - 11/01 and later - these ovens use Valve P/N 45688. The valve operates on a 50 or 60 Hz supply, has a grey plastic cover and a black On/Off knob. It is otherwise identical to the previous version, and may be used to replace it in all cases.

2. Valve Operation

When the ON-OFF knob on the valve is in the ON position, gas is allowed to enter the valve. Once 24VAC is supplied to the valve, gas is supplied to the pilot line.

When the pilot flame has been proved (see *Pilot and Proof of Flame Rectification* on Page 94), 24VAC is supplied to the combination valve by the ignition module, opening the main valve. Gas pressure from the inlet side of the valve is passed through the Pressure Regulator. The regulated pressure is supplied to a cavity below the main valve diaphragm. This pressure overcomes the spring force and moves the main valve to its open position. During operation, the main valve is opened and closed by the pressure regulator to keep a constant pressure at the outlet of the valve.

When power to the valve is cut, the cavity below the main valve diaphragm is depressurized and the valve spring closes the main valve rapidly to shut off the main burner.

When the 24VAC supply to the valve is cut, the valve stops gas flow to both the pilot and the main burner.

The combination valve includes taps to measure both the inlet pressure and the regulated pressure. To ensure accuracy, the regulated pressure should be measured when the oven is on low flame.

3. Servicing the Combination Valve

- *Pilot pressure*

  One of the more common service issues with the combination valve occurs on ovens with the on/off gas regulating system (with a solenoid valve), when the oven is on low flame. During low flame, the servo can "bounce" inside the valve as it searches for the proper level. The bouncing line pressure can also cause surges in the pilot pressure. A properly adjusted pilot will tend to smooth out the surges.

  The best way to check for a properly adjusted pilot is to check the pilot line pressure. This requires a pilot pressure tap in the pilot line. Ovens built 3/94 or later should have the tap installed in the line. The tap is also available as Service Kit P/N 30185 which includes installation instructions.

  Recommended pilot gas pressures are:
  - Wayne burner, natural gas - 3½-4" W.C. (8.71-9.95 mbar)
  - Wayne burner, propane - 8-10" W.C. (19.9-24.9 mbar)
  - Midco burner (all gases) - 5-6" W.C. (12.5-14.9 mbar)

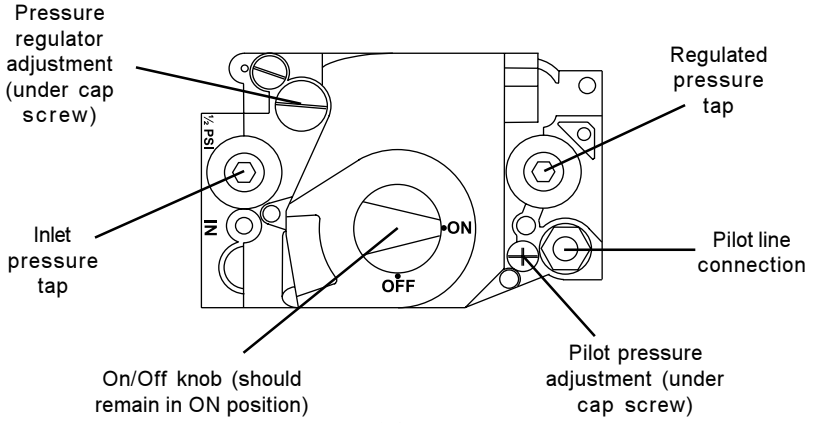
- *Burrs in pilot adjustment portal*

  Some combination valves have been shown to have shipped with small burrs in the pilot adjustment portal. Although this will not interfere with proper operation of the valve in any way, it does make it difficult to adjust the pilot pressure until the burr is removed.

  Check for a burr by attaching a manometer to the pilot pressure tap. If the manometer does not detect any change in pilot pressure when the screw is tightened all the way down, there is probably a burr in the portal.

  To remove a burr, perform the following procedure:
  - Turn the adjustment screw all the way down.
  - Apply more pressure to break through the burr.
  - Back the screw out until the top of the screw is level with the top of the access hole.
  - Turn the adjustment screw back down to adjust the pressure.
  - Repeat these steps until the burr is cleared.

Figure 72 - Combination Gas Control Valve



N. Ignition Module

1. Part Number Reference - Ignition Module

- PS360WB70 and PS360EWB ovens equipped with the Midco burner use Ignition Module P/N 31501.
- For all other oven models:
  - Through 10/90 - these ovens used Ignition Module P/N 27161-0004. Some versions of this module included a separate, replaceable fuse. This module shared a common ground with the 24V transformer and the relay coil. See Figure 73.
  - 11/90 or later - these ovens use Ignition Module P/N 27161-0005, included in Service Kit 42810-0114. The module is internally grounded and the common ground with the transformer and relay coil has been eliminated. See Figure 74.

If you are replacing the obsolete module (P/N 27161-0004) with the current version (P/N 27161-0005), BE SURE TO DISCONNECT THE MODULE FROM THE COMMON GROUND WITH THE TRANSFORMER AND RELAY. Double-grounding of the module creates a feedback voltage circuit that allows the module to operate without a signal from the burner/blower assembly. This procedure is explained in greater detail in the instructions for Kit 42810-0114, included in the *Appendices* section.

2. Module Operation

The ignition module delivers 24V to the pilot ignitor when the blower motor centrifugal switch (or air pressure safety switch) is closed.

When the module detects a current flow of at least 2.0 μA through the pilot flame, it supplies 24V to the combination gas control valve, allowing the valve to operate.

Figure 73
Wiring diagram of ignition and gas valve system (obsolete ignition module 27161-0004)

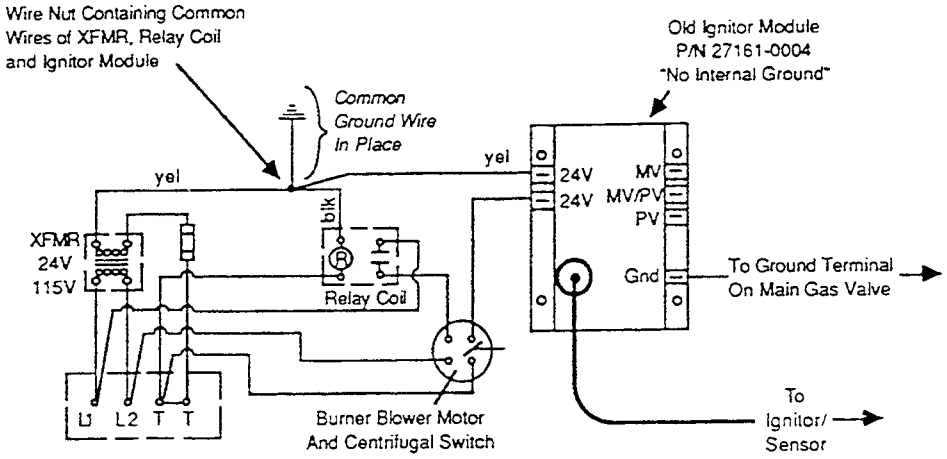


Figure 2

Figure 74
Wiring diagram of ignition and gas valve system (current ignition module 27161-0005)

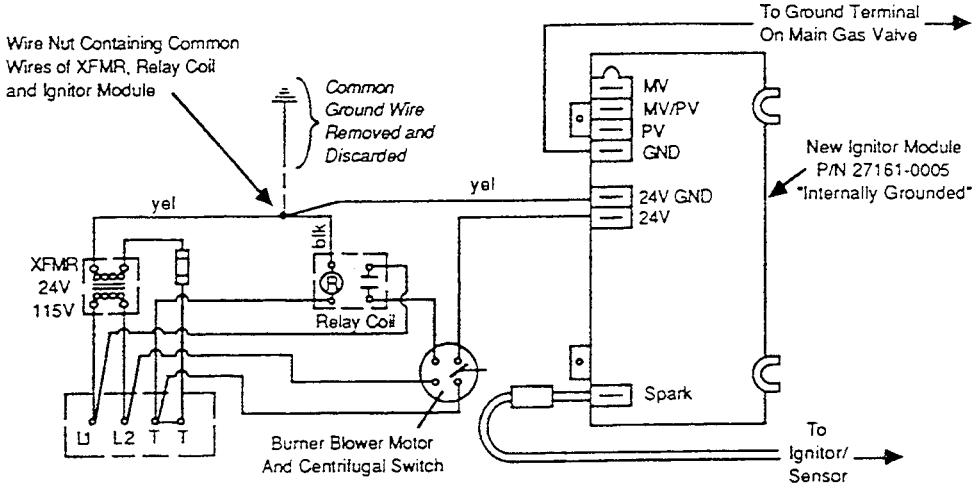


Figure 1

SECTION 5
REFERENCE

25-point preventative maintenance checklist

[ ] 1. Check and clean (blow out) machinery/control compartment.

[ ] 2. Check and clean (blow out) main blower motors.

[ ] 3. Check and clean (blow out and brush) axial fans.

[ ] 4. Check burner blower motor and fan operation.

[ ] 5. Check and clean igniter assembly.

[ ] 6. Check and clean all orifices.

[ ] 7. Install pilot tee if oven is not so equipped.

[ ] 8. Check gas pressures; adjust as necessary.

[ ] 9. Check air-fuel mixture; adjust as necessary.

[ ] 10. Check ignition cable for signs of deterioration.

[ ] 11. Check and tighten all electrical connections.

[ ] 12. Inspect conveyor belt for damage; repair as necessary.

[ ] 13. Inspect conveyor frame pivot plates.

[ ] 14. Inspect conveyor shaft bushings - Replace drive side bushing.

[ ] 15. Check conveyor drive chain tension; adjust as necessary.

[ ] 16. Verify proper air finger arrangement; correct as required.

[ ] 17. Inspect and clean (vacuum) conveyor motor and motor brushes.

[ ] 18. Inspect conveyor motor sensor and magnet; verify correct spacing; adjust as necessary.

[ ] 19. Check conveyor speed control; verify belt speed to be within 10 seconds of set point.

[ ] 20. Verify that proper number of thermocouples are installed.

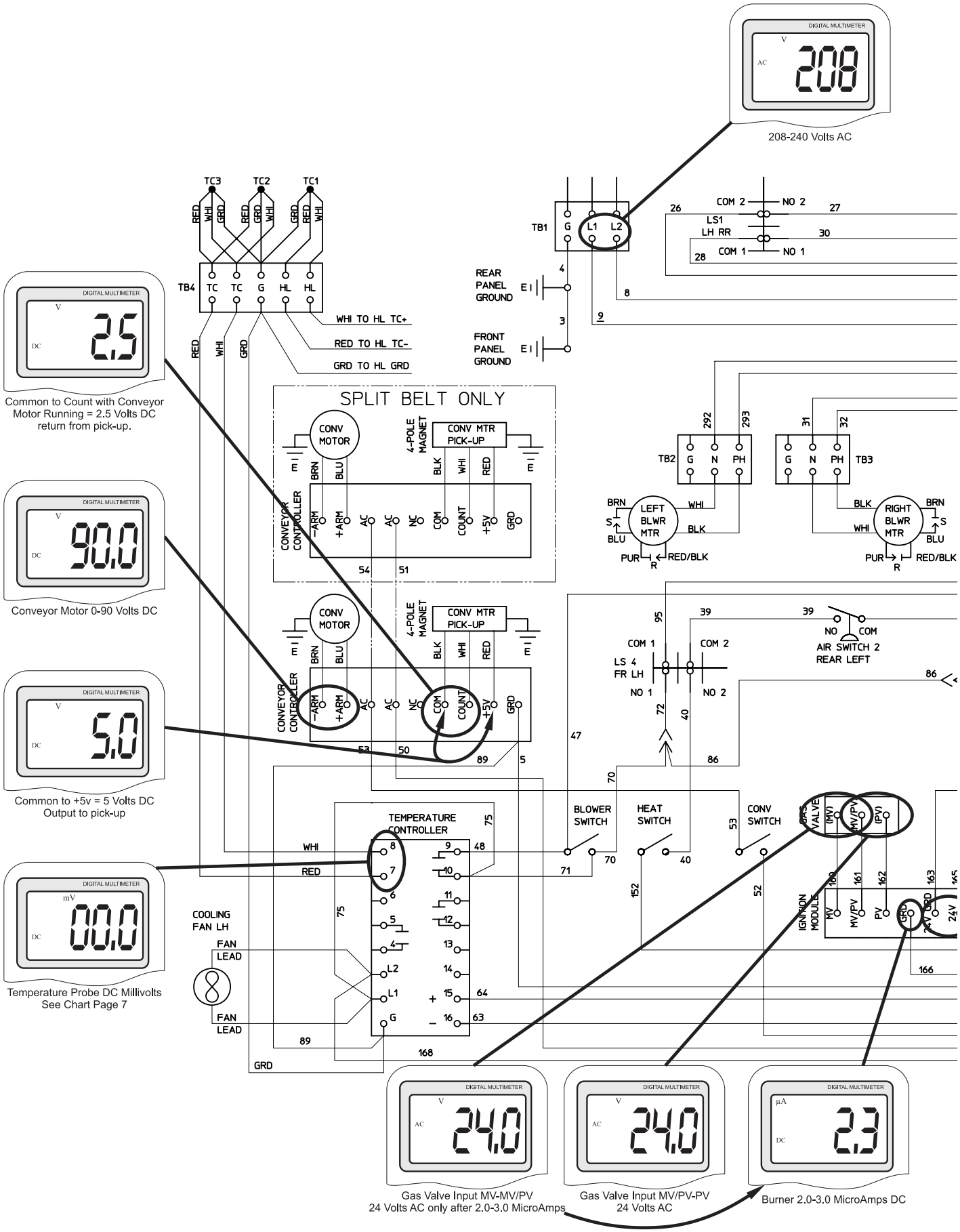
[ ] 21. Check temperature control with thermocouple source to verify accuracy.

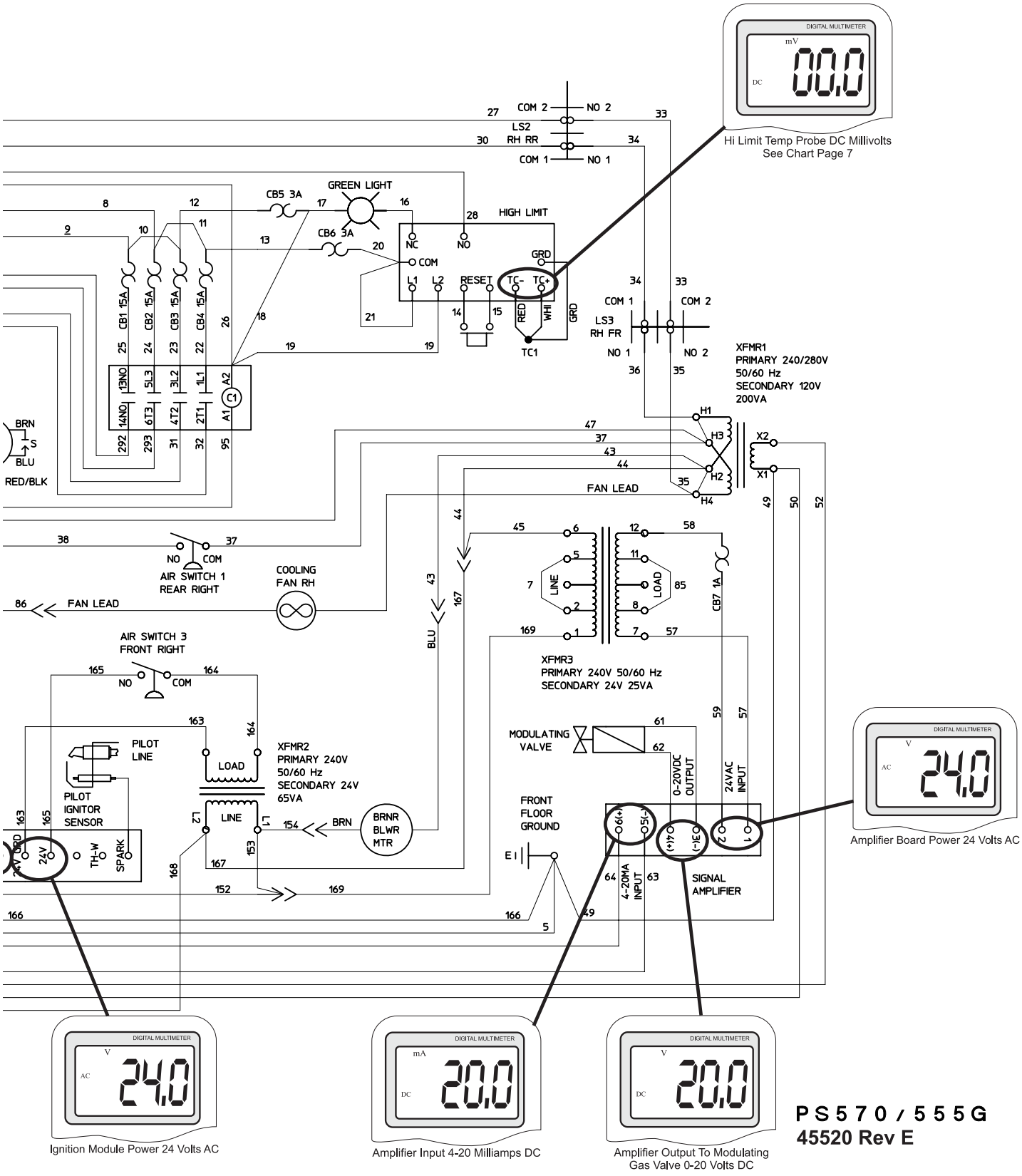
[ ] 22. Check high limit safety circuit with thermocouple source to verify correct operation.

[ ] 23. Check cool down feature with thermocouple source to verify correct operation.

[ ] 24. Using the “read” function of the temperature controller, verify and record the high ambient reading.

[ ] 25. Verify positive ignition on cold start.


208-240 Volts AC
Common to Count with Conveyor Motor Running = 2.5 Volts DC return from pick-up.
Conveyor Motor 0-90 Volts DC
Common to +5v = 5 Volts DC Output to pick-up
Temperature Probe DC Millivolts See Chart Page 7
SPLIT BELT ONLY
CONV MOTOR
4-POLE MAGNET
CONV MTR PICK-UP
CONVEYOR CONTROLLER
TEMPERATURE CONTROLLER
TB1
TB2
TB3
TB4
TC3
TC2
TC1
REAR PANEL GROUND
FRONT PANEL GROUND
LS1 LH RR
LS 4 FR LH
AIR SWITCH 2 REAR LEFT
LEFT BLWR MTR
RIGHT BLWR MTR
BLOWER SWITCH
HEAT SWITCH
CONV SWITCH
GAS VALVE
IGNITION MODULE
COOLING FAN LH
FAN LEAD
WHI TO HL TC+
RED TO HL TC-
GRD TO HL GRD
Gas Valve Input MV-MV/PV 24 Volts AC only after 2.0-3.0 MicroAmps
Gas Valve Input MV/PV-PV 24 Volts AC
Burner 2.0-3.0 MicroAmps DC



PS570/555G
45520 Rev E

Trouble Shooting Middleby Conveyor Ovens
Quick Check list

Modulating Gas Valve

- Is Temperature Controller in PID mode?
- Confirm you have 24VAC input on amplifier board are terminals 1 and 2 - if not, check transformer.
- Confirm 0-20VDC output voltage at terminals 3 and 4 on the amplifier board - if not, check for 4-20mA input to amplifier board from temperature controller at terminals 5 and 6.
- Confirm 4-20mA signal on terminals 5 and 6 of the amplifier board - temperature controller must be in PID mode. - Refer to Middleby Marshall Temperature Controller hand-out, section 4.

Ignition Circuit PS300 Series and PS200 Series

1. The following sequence of events must happen for the oven to light.
   - Each of the main blower motors must either trip a centrifugal switch or an air switch.
   - Once the above occurs, next the transformer on the burner blower motor should be supplied voltage
   - Next, the time delay relay
   - The burner blower motor should come up to speed and trip either a centrifugal switch or an air switch.
   - 24 volts to the ignition module

2. 24 volts between MV/PV and PV terminals

3. Once you have a pilot, you will have 24 volts between MV/PV and MV

4. If these steps have been proven, you have completed the Ignition sequence.

Conveyor

Runaway Condition

- Confirm distance between Sensor and Magnet – business card thickness
- Check common to +5 terminals on speed control – should be 5 VDC
- Check common to count terminal on speed control–2.5VDC with motor running
- If a thumbwheel display, and you do not achieve proper bake time, it is most likely the contacts in the thumbwheel.

Drive Motor Stopping

- Confirm input to AC terminals on speed Control – should be 115 V
- Confirm output voltage from ARM+ and ARM-
- If no voltage, disconnect one ARM, check for voltage. If you have voltage, check drive motor for shorts and also check brushes for wear.

Commercial Food Equipment Service Association

Middleby is proud to support the Commercial Food Equipment Service Association (CFESA). We recognize and applaud CFESA's ongoing efforts to improve the quality of technical service in the industry.

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